Paper B:

On context in phenomenographic research on understanding heat and temperature.

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On Context in Phenomenographic Research on Understanding Heat and Temperature

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Abstract. Starting from an empirical study of lay adults' understanding of heat and temperature, we distinguish between different meanings of "context" in phenomenographic research. To confuse the variation in ways of experiencing the context(s) of the study with the variation in ways of experiencing the phenomenon of study is to risk losing fundamental insights. We discuss context as experienced and as interwoven with the experience of the phenomenon, and analyse its significance in two dimensions: (1) the stage of the research project: formulating the question, collecting data, analysing data and deploying results; and (2) "who is experiencing" the context: the individual, the collective, or the researcher. The arguments are illustrated from the empirical study.

1. Introduction

While discussing the analysis of data from a phenomenographic study of lay adults' understanding of the concepts of heat and temperature (Adawi, in preparation) and discussing the issues that arose, we found ourselves repeatedly returning to the meaning of the "context" for the participants and for ourselves as researchers. And a realisation that we were referring to the notion of "context" in a number of subtly different ways. This led to an attempt to systematise the issues and our responses to them, with reference to both the study in progress and the relevant literature. It is this process of systematisation and the results that we report here, with the aim of developing a way of conducting ourselves in relation to context in our work in researching learning and understanding.

The issue of context appears in a number of guises in educational research. Our arguments are grounded in the phenomenographic approach to studying experience, which means that we are problematising the meaning of and influence of context in aspects of phenomenography – methodology, method, theory development – and phases of phenomenographic research – formulating a research question, collecting data, analysing data, and describing, communicating, generalising and deploying results. Note that we are not explicitly dealing with "context" of learning as such here, important as this might be (van Oers, 1998; Linder,

1993; Linder & Marshall, 2001; Pong, 1999), but with "context" as an issue of phenomenographic research methodology.

First we need to establish what we mean above by the "phenomenographic approach to studying experience". Phenomenography is based on "an interest in describing the phenomena in the world as others see them, and in revealing and describing the variation therein" (Marton & Booth, 1997, p. 111). This implies the researcher taking a second-order perspective on the research phenomenon, devising appropriate methods of data collection and analysis to enable a description of the ways in which the phenomenon is experienced to emerge as a set of descriptive categories, related both logically to one another and empirically to the research question. The situation against which the phenomenon is experienced by others is, in this simple view, relegated to a background; in fact, the analysis deliberately strips away contextual features of the data in order to focus clearly and exclusively on the phenomenon, as experienced. Indeed, to confuse the variation in ways of experiencing the context of a study with the variation in ways of experiencing the phenomenon of study is to risk losing fundamental insights. Focus is not on the way in which the researcher experiences the phenomenon, but on the ways the research participants do; in contrast, it is the researcher who experiences a variation in how the phenomenon is experienced, and seeks meaning and structure in this variation.

But of course, whether it is a research participant or a researcher who experiences a phenomenon, there is always situation with social, spatial and temporal dimensions which lends it meaning. Just as when we experience, we always experience *something*, we always experience that something *as* something; that experience *as* something would be quite different if we placed ourselves in some other grouping of people, or location, or epoch. As pointed out by Marton and Booth (1997),

> We cannot separate our understanding of the *situation* and our understanding of the *phenomena* that lend sense to the situation. Not only is the situation understood in terms of the phenomena involved, but we are aware of the phenomena from the point of view of the particular situation. And, further, not only is our experience of the situation moulded by the phenomena as we experience them, but our experience of the phenomena is modified, transformed and developed through the situations we experience them in (p. 83).

If we replace "situation" with the synonymous "context", we are encouraged to start to study the context which gives meaning to the phenomenon.

Let us return to the notion of context in a more general sense and ask, what does it mean in a general sense? There are dictionary definitions: It is defined in Chambers English Dictionary (1990) as follows: "*n*. the parts of a discourse or treatise which precede and follow a special passage and may fix its true meaning: associated surroundings, setting". And in Mirriam Webster (online) we find more detail: "1: the parts of a discourse that surround a word or passage and can throw light on its meaning; 2: the interrelated conditions in which something exists or occurs", and that its etymology is Middle English, "weaving together of words, from Latin *contextus* connection of words, coherence, from *contexere* to weave together, from *com* + *texere* to weave".

The dictionary definitions confirm the everyday understanding of "context", and the etymological description brings to light the sense of inter-relatedness. It can mean either the text into which a particular passage is woven and which casts light on the passage, or the socio-spatial setting or situation in which an event occurs, and which is intimately related to

the event. In either case, an *outsider,* whether a reader or an onlooker, can gain meaning of a focal passage or event, through consideration of the context, whether languaged or experienced. We immediately note the contrast with the phenomenographic project of describing phenomena (and by implication the context of the phenomena) as experienced by the *insiders* or research participants.

Ekeblad and Bond (1994) have made a similar distinction between the ways in which two different research forms treat the notion of context. On the one hand, in "an *experientialist* perspective … the research question is designed to seek an understanding of what it is that is experienced" whereas, on the other hand "an explanatory or *externalist* approach to research assumes that we are looking at the impact of context *on* an individual" (p. 148; our italics). The first, experientialist, perspective is in line with what we take as our starting point, but nevertheless criticism from this point of view can be found from what we might call the phenomenological fraction of the phenomenography tradition (Ashworth & Lucas, 1998; Ashworth & Lucas, 2000; Friberg, 2000). The "externalist" perspective leads researchers to observe events and to analyse them from within their theoretical and methodological frameworks, rather than seeking to see them through the experiences of the actors in the events.

We will take up other perspectives on context and other forms of research in the discussion following our systematisation of what "context" signifies for the phenomenographic study on understanding heat and temperature, which we generalise to phenomenographic studies in a wider sphere.

2. Analysis of Context – whose context?

The phenomenographic study of lay adults' understanding of heat and temperature by Adawi, from which we draw examples throughout this paper[1] is, as many phenomenographic studies, mainly based on phenomenographic interviews. Such interviews are generally described as semi-structured and open, the most important feature for this paper being that the interview offers a number of openings from which the interviewer and the interviewee are able to explore the phenomenon of interest. Two groups of adults participated in the study, some with only elementary schooling in physics and some who were taking an introductory overview course in physics for the general public given by Adawi, typically without prior experience of physics at the university level. The interview design offered the participants the opportunity to discuss and explain heat and temperature in some everyday situations, such as in cooking, with the aim of exploring their conceptualisation of heat and temperature. As well as the transcribed interview material, the textual pool of meaning was constituted of a number of written commentaries on the nature of heat and temperature, collected from the whole group attending the course.

Since the analysis takes its starting point in the pool of meaning thus constituted from the data, the quality of the data is crucial for what might emerge from the analysis. However, determining the quality of the data is not unproblematic, and a discussion of shared and unshared cultures, use of language, as well as the distribution of power has ensued. The

1 Note that this paper does not report the study as such, or its analysis and its results. In the paper we assume the study as a typical phenomenographic study, and take it as our starting point for a methodological consideration of context in phenomenographic studies in general.

interviews are in no way an objective probe into the interviewee's experiences of the phenomenon of interest, in which dialogue is seen as being comprised of containers of the interviewee's thoughts that are passed over to the researcher for inspection; on the contrary, we see the interviews as a complex interplay between the interviewer and the interviewee, which can range in nature from an interrogation to a negotiation. From our point of view, it is important to distinguish between the two actors in this situation: the *researcher* (and/or the interviewer) who has taken the initiative to the interview, set the topic and in various ways prepared the situation in the ambition that it should be centred on some specific topic, question or phenomenon, and the *interviewee*, whose motives only can be seen through what she or he does or says. There is an imbalance of power in the nature of data collection which the researcher cannot totally redress in spite of attempts to soften it. In such a situation of imbalance, in which context can be (and is) used in many ways, we have found it worthwhile to make a distinction between two different meanings of context:

> The *prepared context*, as defined by or observed by, or indeed experienced by, the researcher; that is, what the researcher considers to be relevant for the interviewee to make sense of the situation at hand. (For example, in Adawi's interviews, two knives of different materials and a cooling cup of coffee were important parts of the prepared context.)
>
> The *experienced context,* as experienced by the participant; that is, what the participant experiences as being relevant for making sense of the situation at hand, this being interwoven with the experience of the phenomenon under consideration.

We found that our understanding of the pool of meaning was enhanced by switching between consideration of these two ways of seeing context – now regarding the experienced context, now the prepared context – and weighing the two against one another. This resembles the approach to researching learning and sense-making known as intentional analysis (Halldén, 1988; Booth, Wistedt et al.,1999) where a consideration of the range of potential contextualisations that an actor is calling upon while making sense of some task or phenomenon is an explicit phase of the research process. Similarly, the phenomenological reduction involves a process of imaginative variation over ways in which a phenomenon is being seen or conceptualised (Uljens, 1993).

In making explicit the distinction between the prepared and the experienced context, we introduce another tool for analysing the variation which constitutes the pool of meaning. It also leads to a consideration of the researcher's need to be aware of what might be taken for granted in the forms of discourse that the researcher, who prepares the context, and the interviewee, who experiences it in some idiosyncratic way, in answer to a criticism levelled at phenomenographic interviews as data (Säljö, 1997, p. 177), which characterises the phenomenographer as tending to treat interview data as being directly linked to experience.

And thus the critical questions were formulated: *When we speak of context in phenomenographic research, whose context are we speaking of? Who is experiencing the context? How can we describe and account for context in a phenomenographic study where the prepared context is apparent but the experienced context is lost in the analysis? How can the researcher work towards an awareness of the context during the stages of the phenomenographic study?*

Within the research project on understanding heat and temperature, in our attempt to systematise our thoughts on context we have discussed it in three distinct levels, referring to whose experience of context we are dealing with.

1) context at the level of the researcher, of relevance throughout the phenomenographic study;
2) context at the collective level, which is the level of greatest interest to the phenomenographic project; and
3) context at the individual level, with its importance at the time of data collection and in deploying the results.

2.1 The researcher's context

It can be claimed that when engaged in a phenomenographic study on learning the researcher stands in the same relation to the object of research as the learner stands to the object of learning. The object of research is embedded in a context, and this context can be said to be what lends meaning to the object. We call this context the experienced context of the researcher. Thus, in the example we are taking throughout this paper, the researcher is informed by such contextual factors as the theoretical and empirical research approaches, physics knowledge, physics educational research, and problems associated with learning and teaching physics. Different aspects come into focus at different phases, constituting a temporal dimension of changing character. The researcher's context is, unless explicitly taken up, visible neither in the original data nor in the results.

A central element in the phenomenographic researcher's context is the researcher's own awareness of the role s/he is playing in the study and the preparations that were made for the context of the data collection – here the prepared context of the interview. The researcher in our case played, perhaps, two roles, being for half the interviewees their teacher on a conceptual physics course for lay people at the university, while for others he was a neighbour, a friend of a friend, a colleague of a colleague, or suchlike, as half the interviewees were non-physicist adults with no direct social or family contacts. He introduced himself to all participants as a doctoral student of physics education with an interest in how adults understand the concepts, the phenomena and the principles of physics. Clearly, physics entered the prepared context; or, to put it in another way, the relation between researcher and participant was characterised by an element of physics.

In preparing the context of the interview he drew on his broad knowledge of anecdotes and everyday effects to do with heat and temperature (for example, why it is so difficult to open the door to the freezer right after it has been closed[2]), in order to open paths of discussion in as natural way as possible, deliberately trying to avoid the demand for a strict natural science discourse from the outset. Nonetheless, in analysing the interview data the researcher can not ignore the power of the situation to bring caution into the interviewee's responses.

Our point here is that the researcher is not devoid of curiosity and insight when doing her or his research, and neither could nor should be so. Some phenomenologists (Ashworth & Lucas, 1998) would demand that the researcher bracket pre-knowledge and pre-suppositions, in order not to frame the results of the research in his or her own terms , but to let the research subject speak and thus reach the essential. It has, on the other hand, been argued forcefully that a

[2] Try it!

phenomenographer engaged in understanding the variation in ways in which students experience, whether heat or recursion or the mole, needs a thorough and multi-faceted understanding of the concepts in question, at all phases of the research (Lybeck, 1981). The researcher moves to and fro, between seeing the phenomenon against his or her own "professional" knowledge context and seeing it as expressed by others, at all phases of the study. What the researcher does need to apply is a process of reflexivity (Hammersley & Atkinson, 1983), becoming aware of the influence of his or her conceptual understanding over the whole research undertaking, aware of what is being bracketed and what is essential to the research undertaking.

The issue of bracketing in phenomenographic research has recently been raised by Ashworth & Lucas (2000), drawing on the phenomenological tradition. They argue that "... it is the student's experienced world that phenomenographic research bases itself on, and therefore steps must be taken – at the beginning and throughout the research – to bracket anything that would lead us from the student's experience." (p 297) while recognizing that a complete bracketing of the researcher's previous knowledge is not possible: "The attempt to bracket will only be partially successful. Some ways of viewing the world are likely to be more difficult to set aside that others." (p. 299). However, where they argue for entering the life-world of the individual we doubt the possibility of this, and we argue for no more than a selective bracketing to avoid steering data and analysis on preconceived paths. By selective bracketing we mean that the researcher retains an awareness of those aspects of his or her knowledge, which are necessary for understanding above all physics-related utterances of the pool of meaning, in order to let the data speak for itself.

2.2 The collective context

The second level of context we will consider comes into play when data is being studied as a whole, and fragments of data are brought into varying juxtapositions in the analysis process. The analysis that the researcher engages in involves a hermeneutic consideration of elements of the textual pool of meaning, seeing them now as isolated fragments, now in relation to the whole from which they are taken (interviews or written commentaries), now in relation to elements from other, similar wholes, and now in relation to the totality of data or to dimensions of that totality. During this process the researcher is taking different views on the content of the pool, focusing respectively on the extract as such and what it might mean set in different contexts, on the fragment as an element of an interview and what the context of the interview design says about it, on the fragment as one of a set of fragments which indicate different sense making and imply different contextualisations.

When analysing the interviews, the researcher finds that light is shed on some utterance made by one interviewee by reading it against the background of the context deduced or assumed by the researcher from reading an interview extract by another interviewee. Switching between these two perspectives allows the researcher to let an aspect of a phenomenon as experienced by one participant interplay with an expression of an experienced context that originates from another participant. This leads us to introduce the notion of *the experienced context of the collective*.

An example of how the researcher uses the concept of the experienced context of the collective to further the understanding of individual utterances is when A1 says that body heat is not "useful", and compares it with other forms of energy:

I: What can't you use it [body heat] for?
A1: It [body heat] is not like, for example, solar energy or electrical energy, or something like that. It's body heat that is left over when one has eaten.
I: Yes, one can't use it for anything?
A1: Not anything in particular, not anything productive exactly. But it depends on if you mean heat in general, then I don't know. Then it's different.

These statements can be understood against the background of the following excerpt from the interview with A2, a mathematician who talks about the relation between the concepts of heat and work, and gives an example:

A2: Mm, that heat...what can I say, one can use some of it...to do work.
I: In what context?
A2: Well, the fact that boiling water can lift the lid on a saucepan…how it [the air] expands and can do work.

These two statements put together bring up a new meaning in terms of the nature of heat: A2 introduces the concept of work, which she relates to the usefulness of heat (i.e. some of the heat can be converted into useful work), in a similar manner to A1. A1's statements can be understood in the context of work as specific examples of when heat and other forms of energy (e.g. electrical energy) can be converted into useful work, but he only expresses a partial whole for these specific examples to relate to.

If the interviews had been studied one by one, this relationship would not have come to light. Thus, the collective context is more than the sum of the individual experienced contexts and has served as a tool to analyse the pool of meaning. Referring again to intentional analysis, we can say that whereas the intentional analysts draw on their own experiences to find variation of potential contextualisations, here the researcher is drawing on the *empirical* collective contextualisation for analysis.

Inherent in the different kinds of context that we bring about and experience in our phenomenographic research are cultural qualities, e.g. uses of language and rules of communication, which are usually taken-for-granted, and are thereby rendered invisible. Marton and Booth (1997) point out that without variation, with only one aspect available to experience, one can not begin to see that aspect. Glimpses of the cultural aspects of the context are occasionally visible to the researcher in the data because of the variation in cultural experience that the individuals of the collective bring to the pool of meaning

As an example of this, A3 offers the following answer to the question "What do you think heat is?":

A3: It is something pleasant, I can say. But if one is thinking of it scientifically, then it is the motion of atoms.

A3 implies that she is adapting to a particular cultural context, since she is being interviewed by a researcher, whom she knows to be physicist, a scientist. A4, picturing heat as related to the movement of electrons, says:

A4: When I'm trying to think of it logically, that's the way I would think. In everyday situations I wouldn't think this way, but now I do.

The interviewee is expressing a certain cultural aspect of the context for the interviews, different from everyday experience. He is influenced by this cultural aspect since his experience is situated in an environment which the interviewer, the dominating part, has chosen.This is an example of a collective context in the sense that A3 elaborates on A4's statement on what an everyday way of thinking of heat could be: something "pleasant". But more important, the two quotes, through their explicit articulation of the cultural aspect, give a background against which all the other quotes can be seen: the interviewees are engaged in establishing themselves in what they feel to be a – somewhat foreign – scientific culture, and reacting to its demands.

Here we have introduced the idea of a collective context, which is present, though normally neglected, in the pool of meaning, and the way in which it facilitates the researcher in (1) making better sense of individual utterances, and (2) bringing to light otherwise neglected aspects of the cultural assumptions present in the study. Now let us consider what the individual's contextualisation means for the research and the researcher.

2.3 The individual's context

When an individual experiences something or talks about a phenomenon, for example during a phenomenographic interview, some aspects of the phenomenon come into focus, while others remain in the background. The phenomenon is thus experienced against and interwoven with an experienced context, what we can refer to as the *experienced context of the individual*

Examples of different experienced contexts of individuals can be seen in the following extracts, which originate from the interviewees responses to the question "What do you think heat is?" A1 (already quoted in section 2.2) replies:

A1: Heat is energy. That, I think, is what I think of.
I: Yes?
A1: And it's about... I see it as some kind of waste product, something that is left in some way. Something that is not especially useful.
I: That's interesting...
A1: At least not body heat. But body heat in general is energy in some form, I suppose.
I: What can't you use it for?
A1: It [body heat] is not like, for example, solar energy or electrical energy, or something like that. It's body heat that is left over when one has eaten.
I: Yes, one can't use it for anything?
A1: Not anything in particular, not anything productive exactly. But it depends on if you mean heat in general, then I don't know. Then it is different.

The initial theme is heat, which brings with it a context of energy and the usefulness of different forms of energy, with which the notion of heat is intertwined.

A4, meeting this question for the first time in the interview, answered, in contrast:

A4: In all matter, there are electrons, and they can be affected. It is like electricity: heat is created, and then it feels hot.
I: So heat has to do with electrons?
A4: I'd think so. But, the sun, what does it heat?
I: Yes, is that electrons too?
A4: It's light really, light rays... that affect what? I don't know.

I: How does the heat come to the earth from the sun? There are no wires from the sun, right?

A4: No, it seems like no heat is coming from the sun to the earth. Well, it is the rays of the sun.... They are probably not so hot in reality, but they probably influence something in our atmosphere, I could imagine, and then it becomes hot. That it is the light that is heating. It has to be something with electrons which exist in the air and in matter, in all materials.

We can only speculate about the individual's context in this extract, but we can, as researchers, create a context in which to interpret the quote. It includes the notion of electrons, which are seen as the microscopic origin of heat, through some sort of mechanism (which we will return to in 3.4). As context we can reveal that A4 is an electrician by profession, and that he is well aware that his discussion partner is a physicist. The existence of such a mechanism and its effects are the focus of attention – what we might refer to as the theme of awareness, following Gurwitsch (Gurwitsch 1964; Marton & Booth, 1997) – while its nature is taken for granted and a part of the context – or the thematic field. Also, the two situations mentioned, electricity and the sun, in which the phenomenon of heat seems relevant, are part of the experienced context and not the focus of attention.

The interview extracts above show that A1 and A4 not only have different views of heat, but also experience them as intertwined with different experienced contexts. We see glimpses of this experienced context through different utterances during the interview, but we never get the whole picture, since the context, as such, is not in focus during the interview.

No interview is perfect, and we would now like the interviewer to have continued: "What are electrons, do you think?" and then eventually related the ensuing discussion back to the notion of heat. This points to an aspect of the interviewer's craft that has not been elaborated on in the phenomenographic literature. Our consideration of the context of the individual – comprising the interviewer's knowledge about the personal and educational background of the interviewee, the prepared context, and the interview discussion that has gone before – give the interviewer a potential tool to distinguish the theme from the thematic field at specific and critical points in an interview, in order to encourage an elaboration on the thematic field which can later give grounds for understanding the interviewee's experience of the context as well as the phenomenon.

3. Analysis of context in the context of a phenomenographic study

In the previous section we tried to analyse three levels of the phenomenographic research project – that of the researcher, that of the phenomenographic collective, and that of the individual research participant – and discuss the implications of considering context at these three levels. We will now analyse context in another dimension of empirical phenomenographic research – that of the phases of the study.

We argue that the outcome of a phenomenographic research project could be strengthened by the researcher being aware of the implications of context and its various aspects during the stages of the research project. While these stages are not, of course, clear cut, but rather parts of an iterative process, we will separate them analytically and discuss context in relation to them using the terminology introduced above.

3.1 Formulation of research question

The aim of a research endeavour is formulated at the outset of a study, the main actor at this stage being the researcher, who himself[3] is influenced by the context he lives in and works in. The goal is formulated in the socio-cultural environment the researcher is a part of and against a background of what issues and results are perceived as being relevant there. In the example we are taking, this includes the researcher's and his colleagues' understanding of physics, an involvement with the pedagogy of physics and a desire to foster understanding of physics phenomena as they impinge on the everyday life of the public. Similarly, the research strategy is influenced by the educational research culture that prevails at his university, and phenomenography is seen to be immediately appropriate for a study with understanding and experience of an area of science in focus. The research question, then, emerges from the researcher's background and immediate context, and is formulated within a field of research related by subject interest and by methodological approach.

In phenomenography, it is the phenomenon (or set of phenomena, here heat and temperature) of interest that is in focus. This phenomenon is known to the researcher in some way (here as a physicist), and the goal and the strategy are aimed at revealing how it is known or understood to others (here lay adults), in other words to inform the research question. In formulating the research question, therefore, the researcher has to be open to ways of knowing the phenomenon other than his own, and has to be open to the research participants experiencing the context in unexpected ways – what we called selective bracketing. The researcher should thereby be avoiding two potential traps: excluding the participants' experienced context(s) from the context of the research question, and taking a common cultural ground for granted.

3.2 Data collection and context

What are the relevant aspects of context in data collection, if one is to maximise the variation in the pool of meaning? Starting with the researcher, the researcher acts in his or her experienced context where a particular interview is seen against the background of earlier interviews and the anticipation of the interviews to be done. That context can be seen as if the interviewee of a particular interview, through the mediation of the researcher, participates in an on-going discussion around a certain phenomenon both with the researcher and all the other interviewees, the latter being intellectually present while physically absent.

The researcher has a certain aim: he wants a particular phenomenon to become the focus of mutual attention in such a way that the participant can reveal the ways in which he or she experiences it, seen from varying angles, against different backgrounds. To achieve this, he *prepares* contexts for the participants to engage with, to experience, and to speak in. In the case of eliciting written texts, this might involve devising a scenario for the participant to relate to. In holding interviews, it includes, in addition, choosing the environment where the interviews are held, choosing the theme of the interview, working out what questions to ask, planning specific follow-up questions that might be needed, and remaining open and flexible, patient and persistent throughout..

[3] Since our researcher into how adults experience heat and temperature is a man, we will use the male prepositions to refer to him. Of course, a female researcher would be in exactly the same situation, and would need to analyse her influencing context.

In Adawi's interview study, a good deal of time was spent on creating a *variation* in the prepared contexts, an effort being made to design situations with potential for opening up a variation in ways of experiencing the phenomena in everyday contexts. For example, the interviewees were handed two knives, a butter knife made of wood and a dinner knife of metal. They were asked to hold them, and then asked to explain why the metal knife felt colder, what their temperatures actually were (i.e. room temperature), to explain the discrepancy between sensation and temperature (if the knives were considered to be at the same temperature), and if they could relate this phenomenon to other everyday situations. Thus the interviewee was drawn into a discussion of the concepts of thermal equilibrium, temperature and conduction.

Another prepared context involved a cooling cup of coffee. In this case, the interviewees were asked: "If you were to cover your hot cup of coffee with a container, which container would be most effective in keeping the coffee hot – a metal one or a wooden one?" The question was followed by a discussion of the particular choice and its relation to some everyday situations. Again, an interesting discussion of the otherwise abstract concepts of heat, conductors and insulators ensued.

However, as noted in section 2.3, a prepared context (and possibly the phenomenon it was prepared to reveal) can be experienced in strikingly different ways by different interviewees – and perhaps in a way that was not originally intended by the researcher. For example, in order to break the ice after introductions and to orient the interview towards thermal phenomena, each interview started by the interviewer quoting the famous mathematician Marcel Grossman:

> When I sat on a chair that someone had just vacated, and felt the heat he had left there, I used to be struck by something close to horror. No longer. I have learned in physics that heat is impersonal, through and through. (Balibar, 1993, our translation)

The interviewer then asked: "What *is it* that you feel when you sit on a chair that somebody just left?". The idea was to get the subjects to start talking about the concepts of heat and temperature: what heat and temperature are; how they are related to each other and to the sensation of hotness and coldness; how heat is transferred from one place to another and possible factors that influence the rate of heat transfer.

A5 answered the question by saying that what you feel is the heat in the chair (that has been transferred to the chair from the person sitting on it earlier) and then went on to offer a microscopic explanation of the nature of heat as well as a mechanism for heat transfer:

> A5: It's a kind of motion, atoms moving when things get hot. When the person sits down on the chair, he has a kind of motion in his butt and he kind of vibrates and transfers that to the chair.

This is a response, physiological in nature, that has some elements in common with the answer a physicist might have given, and the context to the question was experienced, for whatever reason, as one of classical physics. A6, on the other hand (as well as some other interviewees), answered the same question in a completely different way:

> A6: I don't really know what I feel. Perhaps I don't really like it when it's somebody that I don't know well. But if it's my wife or somebody close it's not like that.

In the researcher's context, focusing on physics phenomena, this is an unexpected answer, more psychological in nature than either physical or physiological. This example illustrates that located in the same social, spatial, and temporal surroundings, the contexts experienced by the two interviewees were radically different – physiological and psychological – and thereby, we speculate for the moment and return to in the next section, the ways of experiencing the phenomenon. This example led us to debate the role of the experienced context in the phase of collecting data of a phenomenographic interview.

We argue that by being careful to maintain an awareness of the experienced context in all its complexity in a phenomenographic study the researcher can exploit the prepared context during data collection to strengthen the content of the pool of meaning. One way of supporting a relevant variation in the experienced context of the interviewee – allowing the researcher to see the phenomenon against, and interwoven with, an even wider range of different backgrounds, and use this to see different aspects of the phenomenon – is to use a corresponding variation of the prepared context in the interview.

3.3 Data analysis and results with context in mind

Let us continue with the example we introduced in the previous section. When the two data extracts were considered in the pool of meaning, stripped of context at the collective level, that from A5, above, could be seen within a physics framework, but A6 was strange, trivial even some might think as "feel" can be ambiguous. In order to understand it more the researcher returned to the complete transcript and read the continuation:

> A6 I notice it most of all if I get on a bus, and take somebody's seat

Now the interpretation becomes clearer, someone has "left" their warmth there and A6 is getting it. Focus, then, is on the psychological feeling of the interviewee, his discomfort, which at first seemed irrelevant to the study, but turned out to be related to a way of conceptualising the phenomenon of heat: it is seen as "something" that is contained in and given off by hot objects, some kind of body substance in this case, and therefore something

> A2 …unpleasant that enters the body even if I perhaps don't want it

This is related to one of the two qualitatively distinct ways of conceptualising the ontological nature of heat, *heat as a substance*[4], found in Adawi's empirical study.

If we return to A5's response, with focus on the physiological feeling and an explanation from physics, the contrast with A6's response now becomes clearer. Heat is not being seen as some kind of substance but rather as (a form of energy) associated with the vibrational motion of

[4] Such a way of conceptualising heat is common among physics novices and well documented in the research literature (see Reiner et al., 2000). Historically, it resembles the *caloric theory of heat*, where heat is seen as some kind of fluid (caloric) that flows from hotter objects (rich in caloric) to colder objects (with less caloric). Today, the idea that heat (or coldness) is a substance is still very much a part of our everyday language; we often hear phrases such as "close the window and keep the heat (cold) in (out)".

the constituents of the object. This is related to other of the two qualitatively distinct ways of conceptualising heat, *heat as a energy*[5] from Adawi's empirical study.

Now we confirm what we referred to as speculation in the previous section – these two data extracts serve as catalytic fragments of two distinctly different ways of experiencing the phenomenon of heat (as a substance or as energy), and they emerged in the analysis from two distinctly different ways of experiencing (psychologically or physiologically) the prepared context. At a micro-level of analysis, returning to the prepared/experienced context at the individual level has illuminated the ways in which the phenomenon is experienced at a collective level, and clarified the results at the macro-level – the categories of description.

To cast light on the phenomenon of interest, being interwoven with the individual's experience of context, a collective level of experienced context and ways of experiencing the phenomenon is created by the researcher – a process of decontextualisation and recontextualisation, where decontextualised pieces of individual interviews are recontextualised with other pieces of interviews and the whole set of interviews.

Let us consider the role of *decontextualisation,* which is an essential aspect of the analysis stage of a study, in order to see the phenomenon clearly in the second-order perspective. The very interviews are decontextualised from the situation in which they were made. And then, as the pool of meaning is formed, individual pieces of data are removed from the prepared context and lose contact with the experienced context. The results we are aiming to reveal – the categories of description – are themselves to be decontextualised even at the collective level.

If we turn to the role of *recontextualisation*, we see this as no less than creative and analytical *contextualisation*! The researcher has the freedom to take individual extracts of data and put them into juxtaposition with other pieces of data, or with prepared contexts, or with whole interviews, or even with related research results – all in an effort better to understand the data at hand in a hermeneutic manner, as described in section 2.2. It aims at the ultimate recontextualisation of the entire pool of meaning into the set of logically and empirically related categories of description. It is an instrument to be used carefully and with due respect for the contexts in question as experienced.

As a result of this iterative, non-algorithmic analysis, the researcher finally arrives at a set of logically related categories of description, intended to describe the limited number of qualitatively different ways of experiencing of the phenomenon at a collective level. It is, however, important to note that the categories of description are "our interpretations of others' interpretations" (Johansson *et al*., 1985, p. 249). The researcher is therefore, when analysing the data, in a learning situation, and it is then clear that the researcher's context is of fundamental importance in creating structure and meaning in the categories of description.

When formulating the categories of description the phenomenographic researcher deliberately strips away contextual features to be able to identify the essential variation in how the phenomenon is experienced. As we said in the introduction, to confuse the variation in ways

[5] Speaking as a physicist, objects do not contain heat. The total energy that an object contains as a result of the kinetic and potential energies of its individual atoms and molecules is called *internal energy* (or sometimes thermal energy). Heat (or work), on the other hand, is a way of changing the internal energy of an object. However, this important distinction between the energy *in* a system (i.e. internal energy) and the transfer of energy *between* systems (i.e. heat or work) was not voiced in the empirical study.

of experiencing the context(s) of the study with the variation in ways of experiencing the phenomenon of study is to risk losing fundamental insights [6]. For example, if we look briefly at the two categories of description already revealed – heat as a substance and heat as energy – we can see that they are stripped of the prepared contexts: no mention of seats or knives or coffee cups; they are stripped of individual experienced contexts: no physiological or psychological feelings are seen there; and the individuals' own words are lost (though individual fragments of data are used to illustrate the categories in a full description). The collective context, or spectrum of experienced contexts – even if we have partly revealed them in the analysis – are hidden in the set of descriptions. The researcher's context is once again paramount.

In the final results we can say that the ways of experiencing the phenomenon have been abstracted or *distilled* from the different contexts in which the phenomenon is embedded. And in so doing the phenomenon has been revealed in a more nuanced sense, as a complex of related aspects, subsets of which go to make up the variation of ways in which it is experienced at the collective level. This analytical distillation process is one of decontextualisation and recontextualisation (or creative contextualisation), where the essence of the phenomenon is abstracted, decontextualised and recontextualised into the logical system of categories of description and in relation to the research question as well as this particular phenomenographic research approach.

3.4 Deploying the results in context

In an important sense the three stages already considered go to make up the phenomenographic project. What happens after the arrival at and description of the outcome space depends on the formulation of the research question, and can shift from phenomenography's second-order perspective to a first-order perspective. But the results that are then used are, in themselves, stripped of all context, unless the researcher makes a conscious effort to relocate the results in their original contexts. This can be carried out at any of our three levels – individual, collective or researcher level – as we will expand on here.

At the *individual level*, the researcher can turn the outcome space back on the transcripts of the interviews, or other collected data, and use it to illuminate the individual. This has been done in phenomenographic work such as in Beaty et al. (1997), where a well established outcome space for the ways in which adults experience the nature of learning was used to describe the development of learning in individual adult students over a number of years of distance study.

In the current study, Adawi could make use of the outcome space in a similar way, to study the physics conceptual world of one or more of his participants. For example, it is known that A4, quoted earlier, is an electrician by trade, and voices an association of heat with electrons in the extract we have given in section 2.3. This might be taken to mean that electrons underpin his entire physics world, and that any physics related context is seen in terms of

[6] One way of confusing the two would, for example, be to create an outcome space for the phenomenon of interest in different prepared or experienced contexts. However, this does not mean that we should completely neglect the role of the context(s), even if it is not of main interest. On the contrary, as phenomenographic researchers we can gain a lot by returning to the context(s) and see how different categories of description are related to different contexts. This has been done in phenomenographic work such as that by Johansson et al. (1985), investigating university students' conceptions of force and motion in some everyday contexts.

electrons. But if his whole interview is inspected, for example the part where he is discussing why the dinner knife made of metal feels cold, we find there:

> I: Has something been transferred from your hand to the knife?
> A4: Electrons.
> I: Electrons?
> A4: It's just a word that I'm using right now, because that's the only thing that I can imagine that it is.
> I: So you picture heat as some kind of particles that are being transferred?
> A4: Yes, when I'm trying to think of it logically, that's probably the way I would think of it. […] I mean…something is travelling in the knife, since it's being heated outwards.

Now we see that a more reasonable interpretation is that he is seeking a way of expressing heat as a substance, and it is electrons that come to mind to constitute this substance. An interesting analysis of this case could be made, relating the electrician's experience to his understanding of thermal physics, by analysing what he says about the remaining prepared contexts.

To relate the outcome space to the *collective level* is the most usual turn of phenomenographic research. Studies are most often undertaken in order to gauge the variation in ways of understanding or experiencing that are likely to be found in a large group of people such as a cohort of students (e.g., Booth, 1992; Booth & Ingerman, in press) or school pupils (e.g. Neuman, 1987; Ahlberg, 1992). We have been selective here in discussing phenomenographic research principles, but suffice it to say that the collection of participants has been selected to represent the variation in the population of interest.

In Adawi's study, the interviewees were half students of a evening course on conceptual physics for the general public and half were similar adults not taking the course, while written material was taken from all the course members. Thus the results can be seen as relevant for lay adults as a whole, with a special subset of course takers. Thus, at the collective level, Adawi can describe the variation in ways in which heat, temperature and phenomena related to these concepts are experienced by lay adults, and possibly differentiate between the ways in which the course-takers have come to understand thermal phenomena from the ways in which lay adults do as a whole.

Relating the research outcome to the *level of the researcher* is on the one hand a scientific enterprise – the results enrich the researcher's understanding of his research field, they underpin future research projects and inform the formulation of future research questions. In the particular case of this study there is another, more interesting relation, and that is the relation of researcher's pedagogical research to the researcher's pedagogical practice, and to teaching in general. For this study was expressly designed to bring greater understanding of teaching through revealing the structure and meaning of central phenomena in physics as students experience them – teaching with learning in focus.

4. Summary

We summarise the main points we have made in Figure 1, relating the level of description (researcher, collective, individual) to the phase of the research undertaking (formulating the research question, collecting data, analysing data, and deploying the results) with respect to the significance of *context*. Note that Figure 1 is not intended to be seen as a linear description

of the research process, but an indication of the complex interplay between these aspect of phenomenographic research.

We start with the top left-hand box, reading downwards. The description of Adawi's physics cultural and research background that was given in section 2.1 can be generalised as the researcher's culture and the cultural, the empirical and the research history of the question itself. It is these that underpin the design of the study – how the question can be formulated, who comprises the collective from which data will be collected, how the data is to be collected, and so on. It is the researcher's task at this stage of the design of the study to devise a context for the study which will put the participants at their ease and enable a fruitful discussion to ensue, and to design contexts in which the phenomenon/a of interest can be approached in different ways to maximise the variation that can emerge during the data collection.

From here we can follow the arrow (1) to the individual level at the stage of data collection. The researcher and the individual participant engage in some activity (here interviews) in which the researcher has prepared the context(s) (here questions related to everyday experiences of heat and temperature) to which the individual responds according to her/his experience of those contexts. As the individual participants one by one contribute their data to the study (2), what is seen from the researcher's perspective as the pool of meaning increases at the collective level and the researcher becomes more insightful into the ways in which the participants experience the interview situation (3), and hence the prepared contexts. This gives the researcher successively greater opportunity to further engage with individual participants, using later interviews to explore earlier interviews and unfinished issues that arose there (4): we spoke of the collective being intellectually present though physically absent in the individual interview. Thus the pool of meaning which the researcher is to analyse is formed.

In the phase of analysing data (5), the individual participant is separated from their contribution as it goes to the collective level (6); their interview becomes recontextualised from the particular context in which it took place into the context of the totality of data, the researcher's pool of meaning. As the researcher works with this (7) – bringing individual pieces of data, interpreted in the light of their prepared context and what emerges of their experienced context, into juxtaposition, as exemplified in section 2.3 – the data becomes successively recontextualised into the emergent set of categories of description and the context is relegated to the background. Of course, there is much more to the analysis process than we speak of here, where we focus only on the issue of context and stripping away context.

The results of the phenomenographic analysis – the categories of description that form the outcome space – can be further analysed, or deployed, in various ways. In keeping with our researcher-collective-individual levels we identify three sorts of deployment, in which the results are related to the levels. Relating them to the researcher (8) puts them into the development of the empirical and research culture, where they inevitably find a place. Relating them to the collective (9) gives them the form of an overview, or – as was originally intended in this case – a qualitative evaluation of an educational measure. Relating them to the individual can be part of case studies, as for example Beaty et al. (1997).

	Formulating question	***Collecting data***	***Analysing***	***Deploying results***
Researcher	Background of researcher's culture The question's empirical, research and cultural history Devising prepared contexts to introduce variation around the question and phenomenon/a involved	Researcher using insights into participants' experienced contexts to build more reflexive data Researcher extending insights into participants' experienced contexts	Emergent categories of description with context stripped away Brings phenomenon into focus, relegating context to the background	Categories of description related to the context of the research question => pedagogical considerations Theoretical development
Collective		Collective intellectually present in the process though physically absent Variation in ways of speaking of phenomenon/a in different prepared/experienced contexts Pool of meaning grows, embracing expressions of phenomenon/a as experienced in prepared contexts	Moving towards a recontextualisation in an outcome space of categories of description Totality of pool of meaning, variation around the meaning of the phenomena intertwined with the structure of the pool. Data decontextualised from the individual level, recontextualised into the totality	Categories of description related to the context of the collective => overview of relation between collective and phenomena
Individual participant		The prepared contexts are experienced and fragments of expressions of this experience form the data collection		Categories of description related to individual's contexts => case studies

Figure 1. A summary of the stages of research and the levels of interest when considering context in phenomenographic research.

5. Discussion

With the analysis we have presented here we are able to address certain critics of the phenomenographic approach. Säljö (1997), for example, today standing outside the phenomenographic community, argues for the primacy of language over experience. Language is undeniably important in phenomenographic research: the data is most often in the form of interviews, it is transcribed interview texts that the researcher works with during analysis, and it is extracts from the text that lend meaning to the categories that are communicated as results. Säljö prefers to see these texts as examples of the ways in which interview subjects are handling the discourse surrounding the phenomenon, rather than reflecting in any way their ways of experiencing the phenomenon. Säljö's criticism can be concisely put through the following quote:

> Phenomenographers in the interview situation …, no more than any others, have access to anything except utterances from individuals made in specific situations and with varying motives. […] The phenomenographer's choice is to consider these utterances as indicative of ways of experiencing. (p. 177)

We agree with Säljö's criticism that the assumption that what someone says is equal to what someone in fact experiences is naive. Such criticism, however, seems to confuse the individual and the collective levels, which leads to an understanding that a phenomenographic analysis is an analysis of individual *pieces* of data, where it is in fact an analysis of a *set* of pieces of data at the collective level. It is the whole of the data material, generally interviews, that goes to make up the pool of meaning with which the researcher engages to analyse structure and meaning, inextricably intertwined as they are, from the perspectives of those interviewed – not as a set of individuals but as a deliberately varied and holistic sample of the population of interest. We have characterised this pool of meaning as a relation between the researcher and the set of de- and re-contextualised data: decontextualised in that pieces are taken out of their original whole and creatively re-contextualised within the totality of data and its emergent research meaning. It is in the analysis of the pool of meaning that the context is "stripped away", made to disappear, from the phenomenon.

The naïve assumption amounts to seeing the prepared context in an interview as having a one-to-one correspondence to the experienced context, or to return to the distinction made by Ekeblad and Bond, that an experiential project can be achieved by an externalist method. But Säljö goes further than this, and argues that the phenomenographic research object rather should be a variation between different modes of discourse, to reveal the different ways in which people talk about phenomena, since differences in the discourse between the interviewer and the interviewee threaten to make data meaningless if interpreted in terms of ways of experiences. However, the arguments we produce in this paper give us the grounds to treat "differences in discourse" in terms of differences in experienced contexts to which the researcher takes a principled reflexive turn. The discourse is part of the context that is stripped away from the individual level and hidden at the collective level during the analysis, as the process of decontextualisation and recontextualisation (or creative contextualisation) strives towards a parsimonious yet sufficient set of categories of description. The form of discourse used by the interviewees is not transparent in itself – it does not comprise receptacles of meaning that can be shunted round until like is matched with like to comprise a category of likes. We prefer to see it as bearing meaning and contextually dependent, both spontaneous

and singular; and it is the phenomenographic researcher, with his or her aim to be experiential and see the world as others see it, to devise a research context that can support this contextual dependence for the meaning it bears, and can take the singular expressions and see them in contrast and in contact with other singular expressions, all in the move towards understanding.

Ashworth & Lucas (2000) take a practical perspective on how a phenomenographic study is to be made. Doing so, they briefly touch upon the issue of context, aiming to retain individual contexts in collective results:

> Generalizations across individuals are of value, but it is important that the individual's unique experience is not lost. ... As such, it [the individual profile made on each interviewee in the study used as an example] provides a necessary counter-weight to any tendency to attribute meaning out of context. (p. 304)

Even though we experience the danger they point out here (the assigning of presupposed meaning to data) as real and not to be taken lightly but we prefer to characterise the phenomenographic project, as we have said many times in this paper, as taking its starting point not from the individuals, but from the collective, instead using the context of the collective in creating a "life-world of the collective" in which the research outcome, the categories of description, is based.

In a similar way, Friberg et al. (2000) seem to be taking the individual as their starting point. Discussing the issue of context in phenomenographic studies of nursing, they state of the phenomenographic object of research:

> Understanding or experience as conceptions is the focus of interest. This assumption includes a contextual awareness, in which context seems to be the area where conceptions are generated or identified. The area of interest is not context itself, but the individual's understanding of a certain aspect of reality. During phenomenographical (sic) analysis, conceptions are separated from individuals. Understanding is analyzed as conceptions, "frozen thoughts". The decontextualized conceptions are constant in different situations and constitute a collective consciousness. (p. 37)

Again, we find ourselves approaching the issue from the other direction[7], arguing for making decontextualization in the collective rather than in the individual experience, and the stripping of context transform from an obstacle for understanding of the individual to a tool for describing the collective. In contrast to these two works, the work of Pong (1999) on the influence of context on students' understanding of the economic concepts of price and trade is more in line with ours. He showed how changes in the ways participants experienced the concepts run parallel with changes in focus, and, relating, the phenomenographic results back to individuals, he showed that many of them changed both across different problem contexts (inter-contextual shifts) and within a specific problem context (intra-contextual shifts). In general these so-called conceptual shifts clearly make it impossible to relate an individual exclusively to a particular way of experiencing a phenomenon, or vice versa.

Phenomenography is in a state of ongoing development. The adherents and adepts share a mutual engagement in issues of learning and understanding, knowing and experiencing, and they strive after a second-order perspective where the participants' ways of seeing the world come to the fore in data collection, analysis and reporting. There is a growing repertoire of

[7] And we are bemused by the idea of phenomenography dealing in "frozen thoughts".

concepts and techniques that too often remain unreported and methodologically unproblematised. This paper has been an attempt to question our own practice and methodological underpinnings as phenomenographers and relate our discussion to other such attempts, and we end with a hope that they continue to be explored, in other contexts.

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